# IONIC-LIQUID-BASED PROCESSES FOR THE RECOVERY OF NEODYMIUM AND DYSPROSIUM FROM USED NDFEB MAGNETS

**Sofía RIAÑO[1], Koen BINNEMANS[1]**

[1]KU Leuven, Department of Chemistry, Celestijnenlaan 200F – P.O. Box 2404, B-3001 Heverlee, Belgium

*Sofia.Riano@kuleuven.be*

## Introduction

Recycling of REEs is of importance from an economic, industrial and environmental point of view. For instance, the mining, transportation, processing and waste disposal of REEs have very serious environmental and occupational risks, ENREF_1 besides consequences on the surrounding ecosystems and human health. ENREF_2 Indeed, most of the rare-earth deposits contain harmful radioactive elements (*e.g.* thorium and uranium).[1] Moreover, in 2010, the European Commission published a list of critical raw materials at the EU level,[2] where valuable elements such as neodymium, dysprosium (both critical at short and middle term) and cobalt (not critical at short nor at middle term) can be found.

Ionic liquids (ILs) are organic salts which consist entirely of ions and with a melting point that is generally lower than 100 °C.[3-5] Some of the most interesting properties of the ILs are their chemical and thermal stability, high ionic conductivity and wide electrochemical potential window. Due to their

negligible vapor pressure and low flammability, ionic liquids have been usually labeled as "green solvents".[6] They have emerged as a green alternative for the replacement of the conventional organic phase in solvent extraction processes. Advantages of the use of ionic liquids over typical conventional extractants are low vapour pressure, low flammability and high chemical stability.

## Discussion and conclusions

Rare earths and other valuable metals such as cobalt can be recovered from end-of-life NdFeB permanent magnets through liquid-liquid extraction.[7] Ionic liquids are solvents that consist entirely of ions. Moreover due to the very high concentration of anions, the mechanisms of extraction can be different from the ones with conventional extractants in molecular solvents. In this work, solvent extraction from nitrate media is presented.[8] Neodymium and dysprosium are separated from cobalt by extracting them to the ionic liquid trihexyl(tetradecyl)phosphonium nitrate which can be easily prepared from the commercially available ionic liquid trihexyl(tetradecyl)phosphonium chloride (Cyphos® IL 101). Afterwards neodymium and dysprosium are separated using ethylenediaminetetraacetic acid (EDTA) as a selective stripping agent. Different parameters of the separation process such as contact time, temperature, pH effect and concentration of complexing agents and nitrate salts in the aqueous phase were optimized. The designed process allowed separating cobalt, dysprosium and neodymium efficiently in few steps (Fig.1). The ionic liquid can be easily recycled and efficiently reused again for further separations.

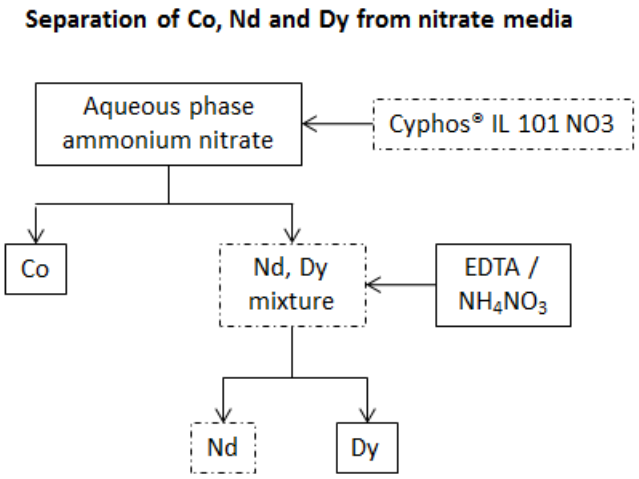


**Figure 1. General scheme of the recycling of rare earth metals by using ionic liquid technology.**

## References


1. K. T. Rim; K. H. Koo; J. S. Park. "Toxicological Evaluations of Rare Earths and Their Health Impacts to Workers: A Literature Review", *Saf. Health Work,* **4** 12-26 (2013)
2. U.S., Department of Energy, Critical Materials Strategy, 2011.
3. T. P. Thuy Pham; C.-W. Cho; Y.-S. Yun. "Environmental fate and toxicity of ionic liquids: A review", *Water Res.,* **44** 352-372 (2010)
4. K. N. Marsh; J. A. Boxall; R. Lichtenthaler. "Room temperature ionic liquids and their mixtures—a review", *Fluid Phase Equilib.,* **219** 93-98 (2004)
5. K. R. Seddon. "Ionic Liquids for Clean Technology", *J. Chem. Technol. Biot.,* **68** 351-356 (1997)
6. H. Zhao; S. Xia; P. Ma. "Use of ionic liquids as 'green' solvents for extractions", *J. Chem. Technol. Biotechnol.,* **80** 1089-1096 (2005)
7. K. Binnemans; P. T. Jones; B. Blanpain; T. Van Gerven; Y. Yang; A. Walton; M. Buchert. "Recycling of rare earths: a critical review", *J. Clean. Prod.,* **51** 1-22 (2013)
8. S. Riano; K. Binnemans. "Extraction and separation of neodymium and dysprosium from used NdFeB magnets: an application of ionic liquids in solvent extraction towards the recycling of magnets", *Green Chem.,* **17** 2931-2942 (2015)